post_incompact3d

We collect here discretized versions of flow statistics and parameters implemented for post-processing for a temporal TBL in the program `post_incompact3d`. Integral quantities are estimated with O(1) accuracy here. For O(6) accuracy, use the Python function `high_order_integrals.py` (same parent directory).

List of statistics, averaged along periodic x and z directions and with different flow realizations:

Velocity field (O(6))

- Averages

$$\langle u \rangle, \langle v \rangle, \langle w \rangle$$

- Variances

$$\langle u'^2 \rangle, \langle v'^2 \rangle, \langle w'^2 \rangle$$

- Skewnesses

$$\mathsf{skew}[u], \mathsf{skew}[v], \mathsf{skew}[w]$$

- Kurtoses

$$\mathsf{kurt}[u], \mathsf{kurt}[v], \mathsf{kurt}[w]$$

Reynolds stresses (O(6))

$$\langle u'v' \rangle, \langle u'w' \rangle, \langle v'w' \rangle$$

Pressure field (O(6))

- Average and variance

$$\langle p \rangle, \langle p'^2 \rangle$$

Scalar field (O(6))

- Average and variance

$$\langle \varphi \rangle, \langle \varphi'^2 \rangle$$

Mixed fluctuations (O(6))

$$\langle u'\varphi' \rangle, \langle v'\varphi' \rangle, \langle w'\varphi' \rangle$$

Vorticity field (O(6))

- Averages

$$\langle \omega_x \rangle, \langle \omega_y \rangle, \langle \omega_z \rangle$$

Mean gradient (O(6))

$$\langle \frac{\partial u}{\partial y} \rangle = \frac{\partial U}{\partial y}$$

Displacement thickness (O(1))

$$\delta^* = \int_0^\infty \frac{\langle u \rangle}{U_w} dy \approx \frac{1}{U_w} \sum_{j=1}^{n_y} \langle u \rangle_j \Delta y_j$$

where

- n_y: number of discretization points in y direction;
- Δy_j: mesh spacing (distance between faces);
- $\langle u \rangle_j$: mean velocity at the discretization points (faces of the elements; 'forward' or 'backward' rectangular rule can be used);
- U_w: velocity of the translating wall.

Momentum thickness (O(1))

$$\theta = \int_0^\infty \frac{\langle u \rangle}{U_w} \left(1 - \frac{\langle u \rangle}{U_w} \right) dy \approx \sum_{j=1}^{n_y} \left(\frac{\langle u \rangle_j}{U_w} - \left(\frac{\langle u \rangle_j}{U_w} \right)^2 \right) \Delta y_j$$

where

- n_y: number of discretization points in y direction;
- Δy_j: mesh spacing (distance between faces);
- $\langle u \rangle_j$: mean velocity at the discretization points (faces of the elements; 'forward' or 'backward' rectangular rule can be used);
- U_w: velocity of the translating wall.

Shear velocity (O(2))

$$u_\tau = \sqrt{\frac{\tau_w}{\rho}} \approx \sqrt{\nu \frac{U(2)}{y_p(2)}}$$

where

- U is the mean velocity array;
- y_p is the array of y coordinate of grid faces.